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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in Composite Textile Yarns and in Processes for Their Production

We, E.I. DU PONT DE NEMOURS AND COMPANY, a Corporation organized and existing under the Laws of the State of Delaware, United States of America, of Wilmington, State of Delaware, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in composite textile yarns and more specifically to varying denier composite yarns and in processes for making them.

Textile yarns from both natural and synthetic fibres have been developed with a wide variety of physical structures. While there are many different purposes and goals which these different physical structures seek to achieve, a large number are designed to provide fabrics with attractive appearance and pleasing handle. One yarn structure used in this way is known as slub or "thick-and-thin" yarn, a structure found in linen fabrics, particularly those of heavier texture. In silk fabrics the effect is called "Dupioni" and is found in men's and women's suits and dress fabrics.

In the manufacture of synthetic textiles, uneven denier effect has been produced in a number of ways. Some of these involve varying the rate at which filaments are drawn away from the spinnerettes or the rate at which filament-forming material is supplied during the process of filament formation, irregular quenching or coagulating treatments of the filaments during formation and, in the case of fibres and filaments which are subsequently drawn, varying rates of drawing. It is also possible to prepare varying denier yarns by specialized spinning or yarn-forming processes from filaments which are in themselves uniform in denier. Such processes, however, generally require elaborate and expensive equipment from which variable denier yarn is produced only at a slow rate. In many cases, when special yarn spinning processes are involved, variations in denier are achieved by regular or irregular spacing of multiple wraps of one yarn component, called the effect yarn, upon a base of a second yarn component referred to as the core yarn. Such two-component yarn systems offer the possibility of very large variations in denier along the length of the yarn. These denier variations produce pleasing effects in fabrics of such yarns. However, because these yarns must be produced by an elaborate winding technique, the equipment necessary is very intricate and variation from one yarn type to another can be achieved only with time-consuming changes in the equipment. Furthermore, since components of these yarns are merely wrapped one about the other, the components tend to become separated with a resulting loss of the desired effect.

It is an object of this invention to provide a novel composite varying-denier textile yarn in which the yarn components are inter-entangled with one another and to provide a process for the preparation of composite varying denier textile yarns in which the relative quantities of core and effect yarns can be varied readily and simply.

According to the present invention at least two groups of continuous filaments are fed at different rates through a turbulent fluid zone and, either in that zone or subsequently, are stretched so as to break the filaments of at least one group while leaving those of another group unbroken by the stretching process. The amount of stretch which may be applied without breaking a filament is just short of the sum of the increase in length required to straighten the filament without

stretching it and the elongation-at-break of the filament. This sum is hereinafter in the description and claims referred to as the "extensibility factor" of the filaments. When feeding untwisted filaments to the turbulent fluid zone, the increase in length required to straighten the filaments in the product is determined by the ratio of the rate of feeding them to and the rate of withdrawing them from the turbulent zone. For the purpose of the present invention the relative rates of feed of the groups of filaments are such as to give a product in which the extensibility factor of one group of filaments is substantially higher than that of another group so that on applying a stretch intermediate between the two extensibility factors one group of filaments is broken while the other is not.

The filaments which break appear in the product as bundles of filaments distributed at random or unevenly along the length of the unbroken components and interentangled therewith. This effect obtained is illustrated in the accompanying drawings where, in Figure 1 the filaments of yarn 3 are shown entangled with the filaments of yarn 4. Normally, the yarn with the lowest rate of feed becomes a core yarn 3 and yarn components with higher rates of feed become effect yarns 4, giving a composite textured yarn of at least two components with the filaments of each interentangled with one another.

The turbulent fluid zone may be produced by means of a yarn-bulking jet of the type described in British Patent No. 732929 or United States Patent No. 2852906 adapted to cause the individual filaments of the yarn to become convoluted and interentangled to produce a bulked yarn as illustrated in Fig. 2 of the accompanying drawings.

Other suitable fluid jets for use in the present invention are described in British Patents Nos. 842742 and 905895. Jets having a forwarding effect on the yarn are particularly desirable. Many of these fluid jets, with appropriate modification as to design and/or fluid used, are suitable as wrapper jets, the essential function of which is only further to consolidate the multi-component structure. While air at room temperature is most convenient for use in these fluid jets, other fluids may be used, such as hot air, steam or other heated fluids. The composite structure may be stretched, if desired, until the filaments with the highest extensibility factor are at their original length but not sufficiently to break these filaments nor to separate the components completely one from another.

The bundles constitute distinct and separate groups of discontinuous filaments, completely surrounding the core member at intervals and sufficiently interentangled therewith to provide a stable slub yarn. These bundles, or slubs, are distinct or separate in that they are each composed of a distinct or separate body of discontinuous filaments, though there may be, of course, some contact between individual bundles. The length of these bundles may vary along the length of the core component.

Although the multicomponent yarns of this invention may be, at least in part, bulky yarns, they are quite different from the bulky yarns produced according to British Patent No. 732929 and United States Patent No. 2,852,906. Because of the difference in the rates of feed between the several components of the yarns of this invention, the filaments bunch together and are not distributed uniformly along the length of the yarn. This results in a slub effect caused by variations in denier along the yarn due to the fact that in some regions a greater quantity of material is present than in other regions. The resulting change in over-all denier gives an effect similar to dupioni or linen-type yarns and is most apparent and attractive when the yarn is woven or otherwise processed into a fabric.

In the simplest preferred embodiment of this invention, the composite yarn is made up of two components, the initial core yarn (prior to breaking) having a substantially lower extensibility factor than that of the initial effect yarn (preferably less than about 1/2), because the latter is fed to the fluid jet at a substantially higher rate—preferably at least twice as fast (twice the unit length per unit time). When this composite yarn is subsequently stretched, the core yarn will break randomly and will form along the threadline a series of slubs giving the composite yarn a variable denier. The initial effect yarn which during the processing is fed into the bulking jet at a much higher rate than the core yarn has a higher extensibility factor, thereby permitting it to remain unbroken during the stretching process which brakes the initial core component. Thus, a reversal of function of the two components occurs, the initial core component becoming the effect component of the final composite yarn while the initial effect component becomes the core component of the final yarn product. During the stretching-breaking step broken sections retract while the unbroken members are elongated and the short bulked lengths become knotted even more firmly into the composite structure. This bunching effect occurs at random intervals along the length of the composite yarn and the frequency of slub sections can be adjusted and controlled by variation of relative rates of feed and denier of components and conditions of breaking. In addition, bulking conditions such as total speed, air pressure, and jet adjustment can be varied to influence

the bulkiness, the degree of entanglement and the degree of loopiness, and thus the eventual physical properties and appearance of the composite yarn.

An alternative procedure consists in applying the stretch simultaneously with the bulking by withdrawing the composite material from the turbulent zone at such a speed that the stretch exceeds the extensibility factor of the group or groups of filaments fed at a lower rate and they are broken while the group or groups fed at the higher rate remain unbroken. Preferably the filaments which are to remain unbroken are fed at at least twice the speed of those which are to be broken. Further to obtain a product in which the core yarn is substantially straight, which is a preferred form, the rate of withdrawal of the composite product may be substantially equal to the rate of feed of the filaments which are to constitute the core yarn or preferably 1-2% lower to provide for increased entanglement of the slub component. A ratio of 2:1 in the feed speeds of the core and slub components gives satisfactory results but higher ratios up to about 50:1 may be used.

The bundles, or slubs, may be further consolidated with the core member by any one of many twisting or treating procedures, such as by a downtwister, spinning frame, wrapping jets, such as disclosed in British Patent No. 871,112 and Application No. 26230/59 (Serial No. 924089), or by a chemical treatment, such as sizing or plasticizing with either heat or solvent. The wrapper jet procedure is preferred in that the slub bundles are then more tightly wrapped completely around the core member. Furthermore, the use of such wrapper jets does not limit the processing speed. In this wrapper jet procedure, the composite product coming from the turbulent zone is fed into a passageway into which a jet of fluid is fed tangentially and hence a torque is applied thereto which wraps the filament bundles constituting the slubs round the core yarn. The vortex zone created by the tangential jet is hereinafter in the claims referred to as a "zone of fluid torque".

A schematic drawing of a suitable apparatus for the process of this embodiment of the invention is shown in Figures 5 and 6 of the accompanying drawings. Core component 8 and slub component 9 are fed off bobbins 10 and 11 respectively into a fluid bulking jet 12 of the type described in British Patent No. 732929 and United States Patnent No. 2852906. The composite yarn structure is then fed into the passageway 14 (see cross-sectional view of Figure 6, taken along line 6-6 of Figure 5) of wrapping jet 15 where it is subjected to a blast or fluid entering through orifice 16, which enters passageway 14 tangentially and then the yarn is wound up on roll 17. For high speed operation, a snubber bar 18 may be placed between the two jets to prevent excessive backing-up of the twist imparted in the wrapping jet into the fluid bulking jet. Tension device 19 may also be provided to control more definitely the tension on core component 8.

Microscope views of two such composite yarns are shown in Figure 3 and 4 of the accompanying drawings, which show bundles 5 and 5′ wrapped completely around core members 6 and 6′. The entanglement produced is generally obscured in the twisted areas but is clearly indicated at 7.

By this invention it is possible to achieve a wide range of varying denier yarns. Size and character of the individual slubs, frequency of occurrency of slubs, variation of maximum and minimum denier, and the amount of residual bulkiness can be easily controlled and regulated.

Various combinations of fluid pressures between the various jet elements may be used to produce variation in the size and length of the discontinuous filament bundles. Similar effects may be achieved by varying the rates of feed of the various components and the tension on the core component during the treating process.

Different rates of feed result in varying composite yarn structures and the different operating conditions of the bulking fluid jet and the wrapping jet give different effects in the yarns produced because of the varying extent of interentanglement and interpenetration of the yarn components of the structure. Jet air pressure may be fluctuated during the formation of the composite structure to produce variations in degree of entanglement or during the wrapping to produce variations in degree of wrapping.

Short period denier variations in the intermediate yarn product (prior to any breaking) of this invention are obtained simply by passing the yarn simultaneously through a fluid jet and then stretching without breaking. Concentration of effect yarn along the composite yarn length can be accentuated by applying intermittent tension by means of a pinching or dragging device to the yarn or by interrupting momentarily the flow of one or more of the yarn components with higher rates of feed. Thus, while over a long length, delivery of this component may be constant, there can be short period fluctuations of several hundred per cent, and the composite yarn denier will vary correspondingly. Interruption of effect yarn flow can be controlled by such devices as cams or rocker-bar arms.

Any combination of two, three, or more different synthetic filaments may be used as the component members of the composite yarn. Also, the yarns of the same polymer in two or more different yarn counts or pre-

dyed and undyed yarns of the same or different polymers may be used in making up the composite structure.

Preferably combinations of components for use in this invention include nylon with rayon; nylon with acrylic fibres; polyethylene terephthalate fibre with rayon, acetate or acrylic fibres; acrylic fibres with rayon or acetate; and nylon with silk or glass fibres.

The process may be carried out continuously with other textile treating procedures, such as twisting, drawing or backwinding.

The following Examples illustrate specific embodiments of the invention. Throughout these Examples, in referring to any yarn the denier is placed first, the number of filaments in the yarn second and the twist, S or Z, if given, is placed third.

EXAMPLE I

Two continuous-filament textile yarns are fed simultaneously to a yarn-bulking jet of the type described in British Patent No. 842742 using air as bulking fluid at sonic velocity. One yarn, a 200 denier, 64 filament blue-dyed cellulose acetate of zero twist, is fed to the jet at 29½ yards per minute while the other, a 200 denier, 34 filament white nylon yarn with ½ turn of Z twist per inch is fed at 57 yards per minute. The yarns are bulked in the jet and the composite structure wound up at 28 yards per minute. The composite structure is rewound on a downtwister with 7 turns of Z twist at 30 yards per minute. In the rewinding process, tension caused by the downtwister breaks the acetate filaments and elongates the nylon filaments, removing all crunodal loops from the nylon. The result is a slub-type yarn with a smooth nylon core, random lengths of discontinuous bulked acetate filaments being intimately interentangled with the nylon core filaments. This composite slub yarn is woven into a plain-weave fabric with a warp of 70-34 "Dacron" (R.T.M.) polyester yarn to give a material with a pronounced slub effect in which only the slubs are blue.

EXAMPLE II

The same jet device is used as in Example I. Three following yarn components are employed:

Yarn	Count	Feed Rate (Yarns per minute)
Pink acetate	100-32-0	41.3
Pink acetate	200-64-0	57
White nylon	200-34-½ Z	100

The composite bulked yarn is wound up at 30 yards per minute and then broken as before on a downtwister. Both of the acetate yarns break, but with different frequency, giving a very random slub effect.

EXAMPLE III

The procedure of Example I is followed, except that in place of the acetate yarn, a rayon yarn, 100 denier, 34 filaments, 2½ Z twist, is used, and in place of the nylon yarn, a polyethylene terephthalate yarn of 70 denier, 34 filaments, ½ Z twist. After breakage, the rayon yarn becomes a slub component on a core of polyester filament.

EXAMPLE IV

The procedure of Example I is followed, except that the nylon yarn is replaced by an acrylic continuous filament yarn, 200-80-0.3 Z.

EXAMPLE V

Two continuous-filament textile yarns are fed simultaneously into an air jet as described in Example I. One yarn, a 75 denier, 24 filament, zero twist navy blue acetate yarn is fed at a rate of 35.5 yards per minute, the other yarn, a 70 denier, 34 filament, ½ Z twist nylon yarn, at a rate of about 425 yards per minute. These yarns are bulked in the air jet at an air pressure of 35 psig.

In the resulting bulked yarn the nylon yarn is intimately interentangled with the acetate yarn, the nylon yarn constituting a core element. As the bulked yarn is removed from the air jet at a wind-up speed of 425 yards per minute, the acetate yarn breaks randomly along its length and is wrapped slightly around the nylon yarn, which has been elongated during its removal from the air jet.

The resulting yarn is then passed into the 1/8 inch passageway of a wrapping jet. Air is forced into this orifice through a 1/16 inch orifice at a rate of 40 psig, tangentially of the first orifice. Upon close examination, this yarn shows a plurality of distinct bundles of discontinuous acetate filaments wrapped completely around the nylon yarn. Under microscope giving a magnification of 10 times, the discontinuous acetate slubs are seen to be intimately intertangled with the nylon yarn core. Some of the individual slubs encircle the nylon yarn core in both S and Z directions, one twist being superimposed over the other.

After inspection, the composite slub yarn is woven into a plain weave fabric with a warp of 70-34 count polyethylene terephthalate fibre yarn to give a decorative material with a pronounced effect produced by the blue acetate slubs.

EXAMPLE VI

The procedure of Example V is repeated except that a 55 denier, 18 filament, zero twist bright acetate yarn is substituted for the navy blue acetate yarn and a 40 denier and 13 filament, ½ Z twist nylon yarn is substituted for the nylon yarn. The feed rate of the acetate component is 27 yards per minute, the rate of the nylon component and wind-up speed being the same as in Example VII. The air jet pressure is 55 psig, the wrapping jet pressure being the same. Both

visual and microscopic examination indicate a similar slub yarn is obtained. When woven into a plain weave fabric with the same polyester yarn, a decorative fabric with a pronounced slub effect is obtained.

EXAMPLE VII

The procedure of Example V is repeated except that 40 denier, 20 filament, 2.5 S twist dull rayon yarn is substituted for the acetate yarn and 70 denier, 34 filament, ½ Z twist nylon is used. The feed rate of the rayon component is 52.5 yards per minute, the feed rate of the nylon component being 840 yards per minute. The yarn is removed from the air jet (operating at a pressure of 15 psig) at a wind-up speed of 840 yards per minute and fed into a wrapping jet operating at an air pressure of 30 psig. Again it is noted that the slubs are separate and distinct bundles of discontinuous filaments wrapped completely around the nylon yarn core. Miscroscopic examination as before shows an intimate interentanglement between the slubs and the core. The phenomenon of right and left twist seen in the product of Example V is again noticed.

A plain-weave fabric is prepared as before to provide a decorative material showing the slub effect.

EXAMPLE VIII

The general procedure of Example V is repeated except that 110 denier, 36 filament, zero twist bright acetate is substituted for the navy blue acetate and 210 denier, 34 filament, 3/5 Z twist nylon is used. The feed rates of the acetate component and nylon component are 27 and 425 yards per minute respectively. The wind-up speed is the same, the air jet and wrapping jet air pressures being 54 and 44 psi respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, although the slubs are just slightly shorter in length than those produced in Example V. A similar woven fabric is obtained.

EXAMPLE IX

The general procedure of Example V is repeated except that 40 denier, 20 filament, 2.5 Z twist dull rayon yarn is substituted for the acetate yarn and 70 denier, 34 filament, zero twist polyethylene terephthalate yarn is substituted for the nylon yarn. The feed rates of the rayon and polyester yarns are 27 and 425 yards per minute respectively. The wind-up speed is the same, the air jet and wrapping jet air pressures being 15 and 30 psi respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, except that the slubs are slightly shorter, as in Example VIII. A similar woven fabric is obtained.

WHAT WE CLAIM IS:—

1. A process for the production of a varying denier composite yarns, which compromises feeding at least two groups of continuous filaments simultaneously through a turbulent fluid zone at such different rates of feed that the extensibility factor of one group is substantially higher than that of another and stretching the composite material sufficiently to break the filaments of the group or groups of lower extensibility factor to form at random intervals along the length of the yarn distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

2. A process for the production of a varying denier composite yarn, which comprises feeding at least two groups of continuous filaments simultaneously through a turbulent fluid zone at different rates of feed to produce a bulky composite yarn in which the extensibility factor of one group of filaments is substantially higher than that of another and subsequently stretching the composite product sufficiently to break the filaments of the group or groups of lower extensibility factor to form at random intervals along the length of the yarn distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

3. A process for the production of a varying denier composite yarn, which comprises feeding at least two groups of continuous filaments simultaneously to a turbulent fluid zone at such different rates of feed to make the extensibility factor of one group, at a rate of withdrawal of the composite material lower than such feed rates, substantially higher than that of another group and withdrawing the composite material from the turbulent zone at such a high rate that filaments of the group or groups of lower extensibility factor are broken and form at random intervals along the length of the yarns distinct bundles of discontinuous filaments interentangled with the filaments of higher extensibility factor.

4. A process according to claim 3, wherein the filaments having the lower extensibility factor are broken by withdrawing the composite yarn from the turbulent zone at a rate approximately equal to the feed rate of the remaining filaments.

5. A process as claimed in any of claims 1-4, wherein one of the groups of filaments is fed at a rate at least twice that of another group of filaments.

6. A process as claimed in any of claims 1-5, wherein the composite product is passed through a zone of fluid torque to consolidate the bundles tightly round the higher extensibility component.

7. A process as claimed in any of the preceding claims, wherein the group of filaments of higher extensibility factor consists of continuous filaments of a synthetic organic polymer and remain unbroken after the stretching.

8. A process for the production of a varying denier yarn, substantially as described in any of Examples I-IV.

9. A process for the production of a varying denier yarn, substantially as described in any of Examples V-IX.

10. A varying denier composite yarn, produced by a process as claimed in any of claims 1-9.

11. A composite yarn of varying denier comprising a core yarn composed of filaments which may be substantially straight or convoluted and disposed at intervals and at random along the length of said core yarn distinct bundles of discontinuous filaments entangled with the filaments of the core yarn.

12. A composite yarn as claimed in claim 11, wherein the discontinuous filaments are wrapped round the core yarn in addition to being entangled therewith.

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924,086 COMPLETE SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

FIG. 1

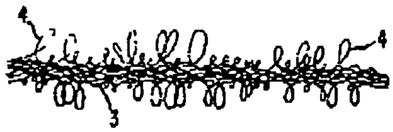

FIG. 3

FIG. 2

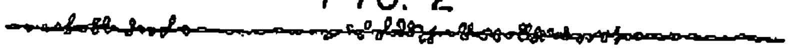

FIG. 5

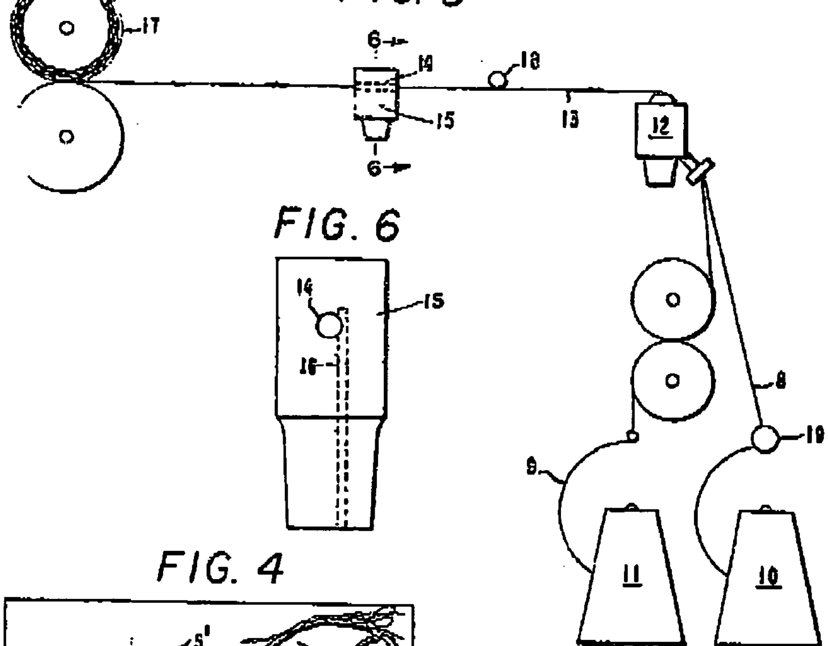

FIG. 6

FIG. 4